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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/649,099	08/26/2003	Woody K. Sattayapiwat Tang	M-12977 US	4957

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EXAMINER

DAHIMENE, MAHMOUD

ART UNIT PAPER NUMBER

1765

DATE MAILED: 11/29/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/649,099

Applicant(s)

TANG ET AL.

Examiner

Mahmoud Dahimene

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08/26/2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-18 and 24-30 is/are pending in the application.
- 4a) Of the above claim(s) 19-23 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-18 and 24-30 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-18, 24-30, drawn to a method for reducing micromasking residue, classified in class 438, subclass 706.
 - II. Claims 19-20, drawn to computer-implementable recipe, classified in class 700, subclass 121.
 - III. Claims 21-23, drawn to a patterned integrated circuit, classified in class 257, subclass 7.

The inventions are distinct, each from the other because of the following reasons:

Inventions I and II are related as product and process of use. The inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product (MPEP § 806.05(h)). In the instant case the process for using the product as claimed can be practiced with another materially different product, namely the method for reducing micromasking residue can be implemented manually by entering the process parameters into the processing system.

Inventions II and III are unrelated. Inventions are unrelated if it can be shown that they are not disclosed as capable of use together and they have different modes of operation, different functions, or different effects (MPEP § 806.04, MPEP § 808.01). In

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the instant case the different inventions the integrated circuit has a different function than the method for reducing micromasking residue.

Inventions I and III are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process, for example, a wet cleaning process can be used to remove residues in the fabrication of the integrated circuit.

Because these inventions are distinct for the reasons given above and have acquired a separate status in the art as shown by their different classification, restriction for examination purposes as indicated is proper.

Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group II and III, restriction for examination purposes as indicated is proper.

During a telephone conversation with Gideon Gimlan on 11/15/2005 a provisional election was made without traverse to prosecute the invention of Group I, claims 1-18, 24-30. Affirmation of this election must be made by applicant in replying to this Office action. Claims 19-23 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Applicant is reminded that upon the cancellation of claims to a non-elected invention, the inventorship must be amended in compliance with 37 CFR 1.48(b) if one

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or more of the currently named inventors is no longer an inventor of at least one claim remaining in the application. Any amendment of inventorship must be accompanied by a request under 37 CFR 1.48(b) and by the fee required under 37 CFR 1.17(i).

For the purpose of examination, the limitation of "said residue can be microscopically observed after the hardmask layer has been patterned", as recited in claim 24, should not be given patentable weight since the term "can be" implies a possibility.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-18 and 26-30 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

2. The expression "sufficiently small in size" in claim 1 is a relative term which renders the claim indefinite. The expression "sufficiently small in size" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention. If the nodules have a base that is anchored in the underlying material one has to define the approximate size of the chemical agent to enter reaction

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zones of the base anchor portions of the residue nodules or define the nodules average size because the term "sufficiently small" is relative to the average size of the nodules.

3. Claim 7 recites the limitation "the fibers". There is insufficient antecedent basis for this limitation in the claim.

Claims 2-6, 8-18 and 27-30 are indefinite because they depend on claim 1.

4. Claim 26 recites the limitation "the ratio". There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-4, 7-11 and 16-17 are rejected under 35 U.S.C. 102(b) as being anticipated by Xiaobing et al. (US 5387556).

Xiaobing discloses an etch method using Cl-containing etchant. The structure etched comprises an interface region of an oxide-based hardmask layer (column 1, line 15) and a metal containing anti-reflexion coating layer (ARC) (column 3, line 20). Some of the interface region is exposed after the hard mask has been patterned (column 1, line 11). It is noted that the thrust of Xiaobing's method is aimed at etching the aluminum layer underlying the ARC layer, Xiaobing, however, discloses a preliminary

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etch step designed to etch (in one example) the TiN ARC layer (column 5, line 48) (Table 1).

The preliminary etch step comprises:

Providing a plasma containing a chemically reactive agent (BCl₃ and/or Cl₂) (Table 1) which react with the Ti (first metal of the ARC layer) to produce a volatile product and therefor etching of the TiN layer is accomplished.

Xiaobing cites testing the amount of residue remaining (column 5, line 63) by comparison to an established wet residue removal method, very smooth profiles were achieved, and no micromasking is mentioned as a result.

As to claim 2, Xiaobing discloses an etching step wherein the chemically reactive agent is selected from the group consisting of Cl₂ and HCl (Table 3). Application of this step, with the rest of the steps of the disclosed process, result in a structure with low residues (column 5, line 64).

As to claim 3, Xiaobing discloses an etching step wherein the process gas consists essentially of HCl, Cl-containing etchant and N₂. The Cl-containing etchant can consist essentially of Cl₂, SiCl₄, CCl₄, BCl₃, or mixtures thereof (column 3, line 43). Application of this step, with the rest of the steps of the disclosed process, result in a structure with low residues (column 5, line 64).

As to claim 4, Xiaobing discloses Ti (column 3, line 20) as the metal contained in the ARC layer.

As to claim 7, Xiaobing discloses one other additional chemically reactive agents such as CCl_4 and SiCl_4 (column 3, line 43) which can react with and volatilize materials present in the base anchor portions of the residue nodules and or fibers since the nodules or fibers contain the first metal element.

As to claims 8 and 9, Xiaobing discloses a second agent N_2 (Table 1). Nitrogen is relatively, chemically nonreactive and is sufficiently large in average mass for physical bombardment.

As to claim 10, Xiaobing discloses 10 sccm of Cl_2 first agent (Table 1).

As to claim 11, Xiaobing discloses 50 sccm of N_2 second agent (Table 3, column 5).

As to claim 16, Xiaobing describes a plasma process power ranging from 100 Watts to 1000 Watts (column 4, line 16) which includes the power range claimed by the applicant in claim 16, and more specifically Xiaobing discloses power levels of 500 Watts (Tables 1 and 3) and 350 Watts (Table 3).

As to claim 17, Xiaobing discloses a plasma or pedestal bias of 200 Watts (Table 1)

3. Claims 24, 25 and 26 are rejected under 35 U.S.C. 102(e) as being anticipated by Chiu et al. (US 20040157444).

Chiu discloses a photoresist intensive patterning and processing wherein a layer (12) of Anti Reflective Coating TiN (ARC) (page 3, paragraph 56) is first deposited over the surface of a silicon based or oxide based semiconductor surface (figure 2), a dual

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hardmask is deposited over the surface of the layer of ARC, in one example, the dual hardmask comprises an oxygen-poor silicon oxynitride interfacial layer (14) deposited between the ARC layer (page 3, paragraph 59) and a silicon oxide layer (16) (page 4, paragraph 60) or PE-TEOS (page 3, paragraph 57). A layer of soft mask material (18) is next coated over the surface of the dual hardmask layer, the layer of soft mask material is exposed, creating a soft mask material mask. Chiu further discusses a residue free cleaning procedure (page 4, paragraph 65).

Since the reference of Chiu teaches the same method using the same materials/layers as the claimed method, under the principle of inherency, Chiu's method would have reduced formation of micromasking residues between a metal containing ARC and the oxide-based hardmask layer.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claims 5 and 6 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xiaobing et al. (US 5387556) in view of Tang et al. (US 6156485).

The method of Xiaobing as described above does disclose an oxide hardmask (column 1, line 15), but is silent about a specific oxide namely a PE-TEOS oxide.

Tang describes a metal etch method where a PE-oxide (140) or PE-TEOS (column 3, line 67) is used on top of a TiN ARC layer (130) (figure 3A).

Therefor it would have been obvious to one of ordinary skill in the art at the time the invention was made to use a PE-TEOS hard mask on top of a TiN ARC layer for a metal etch process because Tang teaches it is conventional to use those materials when etching an underlying metal layer.

6. Claims 14 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xiaobing et al. (US 5387556) as applied to claim 8 above, and further in view of Ueda (JP 11097428).

The method of Xiaobing, as described above, teaches a process pressure range from about 1 mTorr to about 300 mTorr (column 4, line 36), but fails to disclose specifically a process pressure range of about 2 mT to about 15 mT or about 6 mT to about 12 mT.

Ueda discloses a method for dry etching metal that "completely eliminates residual after processing" the method uses an HCl/Cl₂/BCl₃ mixture at 8mTorr.

Therefor it would have been obvious to one of ordinary skill in the art at the time the invention was made to select a process pressure in the range of 2 mTorr to about 15 mTorr or about 6 mT to about 12 mT, because the lower pressure range (around 8 mTorr) allows a higher diffusion mean free path for the chemically active agents to

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reach the processing surface before recombination within the plasma. One of ordinary skill in the art would have been motivated to use the lower pressure range to access small features within the surface to be processed.

Allowable Subject Matter

7. Claims 12, 13, 18 and 27-30 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this office action and to include all of the limitations of the base claim and any intervening claims.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Mahmoud Dahimene whose telephone number is (571) 272-2410. The examiner can normally be reached on week days from 8:00 AM. to 5:00 PM..

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on (571) 272-1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Muhammad Dahimene
MD

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PRIMARY EXAMINER

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